Analysis of pore scale processes in geo-materials: perspectives on multi-scale and time-resolved 3D imaging

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Abstract. The study of transport and degradation processes in porous geo-materials bears importance to a variety of real-world problems, both in underground geological reservoirs as above ground (e.g. CO_2 sequestration, building stone degradation and erosion). To fully comprehend the impact these processes have on large-scale structures, it is crucial to understand what happens on the pore scale level. Over the past decade, the availability of good laboratory-based X-ray micro-computed tomography (micro-CT) scanners has enabled many researchers to image and analyze a geo-material's pore space in 3D. However, a number of important challenges in both the acquisition as the analysis of 3D pore space information persists. On the one hand, specialized imaging, analysis and modeling techniques are needed to deal with the multi-scale aspect of many geo-materials. On the other hand, understanding the dynamics of pore-scale processes requires in-situ, time-resolved imaging. In this talk, we present the progress on these two key issues at Ghent University's Centre for X-Ray Tomography (UGCT). We show the development of multi-scale pore network models and the combination of micro-CT with new high-resolution imaging techniques (e.g. ptychographic tomography) to deal with the former problem. Regarding the latter challenge, we present our advances in (fast) in-situ, lab-based micro-CT imaging of transport and degradation processes in porous geo-materials (e.g. two-phase flow, salt crystallization, reactive flow). We also offer an outlook on the need for further hardware and software development in this field.